DRAFT --- March 2006

Appendix D

Correspondence Regarding the Historical Reconstruction of the Salinity Time Series for the Taylor River for the Period 1970 – 2000.

July 11, 2005

Ms. Melody Hunt, PhD
South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406

Subject: Extension of Taylor River Salinity Historical Reconstruction (1970-2005)

Dear Ms. Hunt:

Environmental Consulting & Technology, Inc. (ECT) has previously prepared a historical reconstruction of the salinity time series for the Taylor River monitoring station (also known as Argyle Hendry and TR) located in Taylor Slough in Everglades National Park (ENP). The Taylor River station is a part of the ENP Marine Monitoring Network, and salinity has been measured there since July 14, 1988. As part of the Minimum Flows and Levels modeling work, ECT developed a historical reconstruction of the salinity time series for Taylor River for the period 1970 through 2000. It was requested that the historical reconstruction be extended to the most recent date possible, given the limitations of the data, and that the dataset be "refreshed".

To begin this task, a new reconstruction data set was prepared, which is comprised as follows:

- Craighead Pond stage (CP) data are the original data obtained from DeWitt Smith of Everglades National Park from beginning of record on October 1, 1978 through October 31, 2002, with data from November 1, 2002 through November 3, 2003 obtained from the South Florida Natural Resources Center website, www.sfnrc.ever.nps.gov (see note below), and evaluated for completeness;
- P33 stage data were obtained fresh from the SFWMD DBHYDRO database website, www.sfwmd.gov/org/ema/dbhydro;
- P35 stage data were obtained fresh from the SFWMD DBHYDRO database website;
- P37 stage data were obtained fresh from the SFWMD DBHYDRO database website;
- Key West water level (kwwatlev) data were the data originally assembled for the Critical Ecosystems Studies Initiative (CESI) multivariate linear regression modeling project (Marshall, 2003) from January 1, 1970 through October 31, 2002, and for November 1, 2002 through November 3, 2003 new data were obtained from the National Ocean Service (NOS) website. http://tidesonline.nos.noaa.gov/ ; and
- Taylor River salinity (TR) data were the original data obtained from DeWitt Smith of Everglades National Park from beginning of record on July 14, 1988 through October 31, 2002, with data from November 1, 2002 through May 22, 2005 obtained from SFWMD and compared to the incomplete data available from the South Florida Natural Resources Center website (see note below).

The available data in DBHYDRO for P33, P35, and P37 ends on November 3, 2003, which is the limit as to how recent this data can be used in the MLR salinity model for Taylor River.

For the CP stage data, the original data were directly downloaded from the ENP validated database, and are known to be a complete series, with missing values included. Data that were downloaded from the SFNRC website are known to contain missing values along with missing dates that are not represented in the downloaded time series. Therefore, for the approximate two-year period of data obtained from this site, the data were evaluated visually and an appropriate symbol for missing values entered where needed.

For the National Ocean Service Key West water level data, data can only be downloaded for a year at a time, in hourly values that must be averaged to daily average values. This laborious process had been completed previously for the data from1970 through 2000. It was beyond the scope of this project to freshen this data. However, new data were downloaded and processed into daily average values for the period January 1, 2001 through November 3, 2003.

As was presented in the December 7, 2004 letter report, the model that was used to fill the period January 1, 1970 through July 13, 1988 and missing values in the observed Taylor River data was the CESI Taylor River multivariate linear regression (MLR) salinity model originally developed from observed salinity data for ENP (Marshall, 2004). The daily value salinity model is:

Taylor River salinity = 83.17 - 15.09CP[lag4] + 0.835Kwwatlev - 7.83(P33-P35)[lag1] - 4.34(P33-P35)[lag4]

where:

CP = stage (NGVD) at Craighead Pond
Kwwatlev = Key West water level (MSL)
P33 = stage (NGVD) at P33
P35 = stage (NGVD) at P35
Lag1 = one-day lag
Lag4 = four-day lag.

Details on model development can be found in Marshall, 2004. For historical reconstruction modeling purposes the Craighead Pond record had to be extended into the past before the beginning of the period of available CP data of October 1, 1978 using the following model:

Craighead Pond (CP) water level = -0.165 + 0.47 P37 + 0.49 P37[lag3], $R^2 = 0.87$.

For the extended Taylor River salinity historical reconstruction, the daily values for CP were simulated by this model for January 1, 1970 through September 30, 1978.

The extended daily Taylor River salinity reconstruction is presented as Figure 1 which shows that this reconstruction is a mix of modeled and observed data. For the period January 1, 1970 through September 30, 1978 CP input was simulated by the P37 model presented above. Then this simulated CP data were used with observed data for P33, P35, and kwwatlev in the TR MLR salinity model presented above for January 1, 1978 through September 30, 1978. The values on Figure 1 simulated in this manner are shown in blue. From October 1, 1978 through July 13, 1988 (magenta-colored line on Figure 1) all input data to the TR MLR salinity model were observed data, and the Taylor River salinity for this period is produced by the model using observed input values. From July 14, 1988 through May 22, 2005 all data (yellow line) observed Taylor River data are available and are utilized. Any gaps in the observed Taylor River salinity data were filled by the MLR salinity model, assuming that all input data to the model were available for that day. To summarize, the reconstructed Taylor River salinity time series consists of data that were generated from CP and Taylor River models from January 1, 1970 through September 30, 1978; using the Taylor River model only from October 1, 1978 through July 12, 1988; and from observed data from July 13, 1988 through May 22, 2005.

Because it is desired that the historical reconstruction be utilized at a monthly time scale, the daily values in the Taylor River mixed reconstruction presented above were averaged to monthly values. There were several months that contained missing values for more than 15 days out of the month, and these monthly averages were not retained in the monthly mixed reconstruction time series, instead being replaced with a missing value for that month. The months with more than 15 missing observed salinity values are as follows:

- 1975 – June
- 1978 – November
- 1979 – December
- 1982 – November
- 1983 – April, May, June, October, December
- 1984 – September
- 1988 – January, June
- 1992 – September, November
- 1993 – July
- 1994 – December
- 2003 - December
- 2004 - January, February, March, April.

Examination of the daily and monthly plots and the daily uncertainty statistics from the previous reconstruction show that the daily simulated values have a tolerance of about +/- 4.5 psu. However, some daily values may be as much as 10-15 psu in error during the month of May, and, to a lesser extent, April, June, August, and September. Monthly average values are generally within about 4 psu but individual averages may have an error of about 9 psu. Because of the potential for large residuals, particularly at the daily level, the following model limitations were previously presented and are repeated here:

- The highest variability is associated with the relatively short periods when the dry season is ending and the wet season is beginning; however, the exact date or period that this happens is not predictable.
- Because flow in Taylor Slough can cease for relatively long periods of time during extended drought periods, salinity simulations have the potential for high variability during extended droughts.

Even with these limitations, plots of the reconstructed salinity look reasonable, except for the maximum values during the 1970-1974 drought when CP is estimated indirectly from the P37 model.

Should you have any questions regarding this extension of the Taylor River historical salinity reconstruction, please give me a call.

Respectfully,

Frank E. Marshall III, PhD, P.E.

Figure 1. Extended Taylor River (TR) salinity daily historical reconstruction, 1970-2005 using a mix of simulated and observed data.

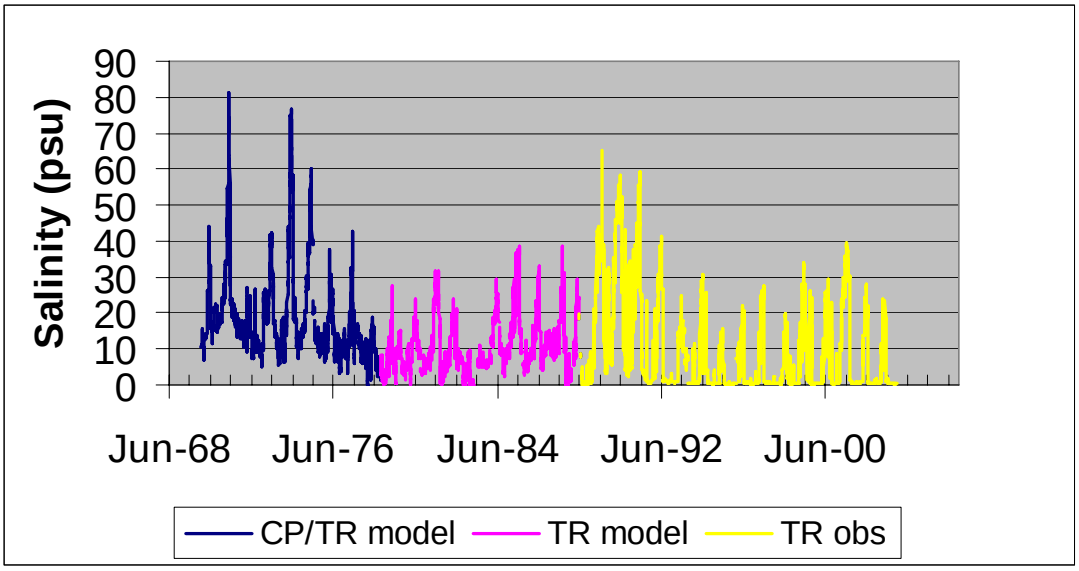

Figure 2. Extended Taylor River (TR) salinity monthly historical reconstruction, 1970-2005 using a mix of simulated and observed data.